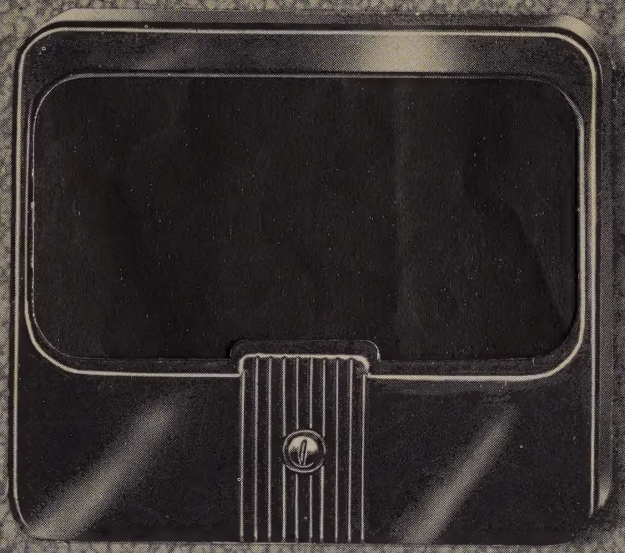
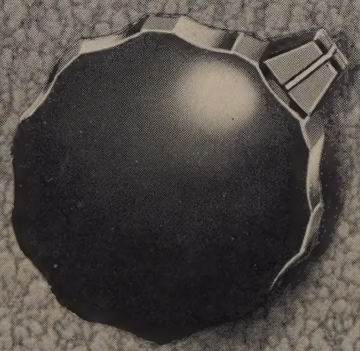
Kepco

INSTRUCTION MANUAL



VOLTAGE REGULATED POWER SUPPLIES



MP MASTER
MA33932

Kepco Inc.

RETURN TO
AEROSPACE DIV.

INSTRUCTION MANUAL

VOLTAGE REGULATED POWER SUPPLY

MODELS SM 36-5 AND
SM 36-5M

SERIAL NO. .....

AEROSPACE DIV.

OFFICIAL RECORDS STATION
FILE COPY
FACILITIES

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PROCEDURES
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kepco inc. 131-38 SANFORD AVENUE • FLUSHING 52, N. Y. • Area Code 212 IN 1-7000 • TWX # NY 4-5196

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SPECIFICATIONS AND CONTROLS FOR MODELS SM 36-5 AND SM 36-5M

I. ELECTRICAL AND PHYSICAL SPECIFICATIONS:

....DC OUTPUT VOLTAGE:
0-36 volts DC, continuously variable.

....DC OUTPUT CURRENT:
0-5 amperes, continuous duty.

....AC INPUT:
105-125 volts, 60 ± 1/2 cps, 3.65 amperes (max.)

....REGULATION:
Line: 0.1% for 105-125 v line change at any output voltage within specified range.
Load: 0.1% or 0.003 v, whichever is greater, for 0 to 5 amperes load change, at any output voltage within specified range.
REMOTE ERROR SENSING feature provides means of maintaining specified regulation directly at load. (See P. C-2).

....RIPPLE::
Less than 0.001 volts rms.

....STABILITY:
Output voltage variation is less than 0.1% over a period of 8 hours, after unit has reached equilibrium. Approximately 3/4 of an hour is required for this unit to reach equilibrium from a "cold start".

....OUTPUT IMPEDANCE:
Less than 0.01 ohm from DC to 1 KC.
Less than 0.1 ohm from 1 KC to 100 KC.

....RECOVERY TIME:
50 microseconds.
Recovery time is defined as the time required for the output voltage to return to within 0.1 volts of the output voltage setting.

....TEMPERATURE COEFFICIENT:
Output voltage changes less than 0.05% per unit C.

....AMBIENT OPERATING TEMPERATURE:
-20C to +50 C maximum. Protective circuit turns off unit whenever over-temperature condition occurs in pass elements. Interrupting input power resets unit.

....STORAGE TEMPERATURE:
-40 C to +85 C.

.... DIMENSIONS:
3-1/2" high x 19" wide x 13-7/8" deep (behind panel).

.... COLOR:
Kepco Standard Gray Hammertone.

.... METERS: (APPLIES ONLY TO MODEL SM 36-5M)
Voltmeter: 0-50 volts, 2-1/2".
Ammeter: 0-5 amps, 2-1/2".

II. TERMINALS AND CONTROLS:

.... (On front panel):

.... DC OUTPUT AND GROUND binding posts, clearly marked. Output terminals isolated from chassis; either positive or negative terminal may be grounded.

.... VOLTAGE CONTROL, continuously variable, for setting output voltage.

.... POWER ON-OFF SWITCH, energizes power and auxiliary transformers.

.... (At rear of unit):

.... DC OUTPUT AND GROUND binding posts, clearly marked; either positive or negative terminal may be grounded.

.... REMOTE ERROR SENSING binding posts provide means of maintaining specified regulation directly at load. (Diagram and Procedure on P. C-2).

III. PROTECTIVE FEATURES:

.... FUSE PROTECTION:
POWER input fuse (ac) on front panel.
DC output fuse (ac) on front panel.
REFERENCE fuse (ac) protects internal circuitry.

.... OVERLOAD PROTECTION:
Provided by inherent current limiting action of Kepco "FLUX-O-TRAN" transformer. Output may be shorted momentarily without damage to unit. Continuous overload or short will blow DC FUSE.

.... OVER-TEMPERATURE PROTECTION:
Thermostat relay control turns unit OFF if temperature of PASS elements exceeds safe limit. Relay is reset by interrupting input power with ON-OFF switch on front panel, or by disconnecting line cord from power source.

SECTION B

BRIEF THEORY:

Two circuit schematic drawings titled "POWER UNIT" and "CONTROL UNIT" are included in the Reference Index of this instruction manual. These drawings contain designations corresponding to the capitalized terms in the following discussion.

Some basic functional relationships in this power supply are illustrated in block Diagram B-1 (Page B-2A).

The POWER UNIT includes:

DC SOURCES:

....MAIN SUPPLY - (consisting of a Kepco "Flux-O-Tran" transformer, full wave bridge rectifier, and capacitive filter) provides line regulated DC power for the output, via the PASS CIRCUITRY.

....AUXILIARY SUPPLIES: COLLECTOR SUPPLY (negative full wave rectified) for PASS CIRCUITRY driver stages not connected to MAIN SUPPLY; I_{CO} SUPPLY (full wave rectified) compensates for spurious biasing effects of collector leakage current; RETURN SUPPLY (full wave rectified) acts as leakage current path for series pass transistors and as bleed path to provide minimum operating current for pass transistors; CONTROL UNIT SUPPLY (full wave rectified).

PASS CIRCUITRY:

The power transistors which function as pass elements (i.e. are in series with the load) may be regarded effectively as variable resistors (or conductors) controlled by a CONTROL SIGNAL. The current "passed" by these elements is a function of the emitter-base bias. The CONTROL SIGNAL is applied to the base terminal; hence a negative CONTROL SIGNAL will aid the forward conduction of a PNP transistor while a positive CONTROL SIGNAL will reduce the forward conduction. In response to the CONTROL SIGNAL the pass elements effect a current and voltage distribution in the main DC loop which holds the output voltage constant.

The CONTROL UNIT includes:

REFERENCE CIRCUITRY:

The function of the REFERENCE CIRCUITRY is to maintain a precise, stable, voltage standard for the COMPARISON AMPLIFIER.

COMPARISON AMPLIFIER:

The COMPARISON AMPLIFIER is essentially a series of cascaded transistor amplifiers which boost the differential error signal produced in the COMPARISON BRIDGE to a level sufficient to drive the PASS CIRCUITRY. The COMPARISON AMPLIFIER is connected across the COMPARISON BRIDGE from the junction of the VOLTAGE CONTROL and the REFERENCE RESISTANCE to the junction of the REFERENCE DIODE and the negative output terminal (See Diagram on Page B-2A). This arrangement is similar to that of a null galvanometer across a Wheatstone bridge. Unbalance in the COMPARISON BRIDGE is amplified to produce a CONTROL SIGNAL of suitable magnitude and phase to effect corrective action by the PASS CIRCUITRY.

COMPARISON BRIDGE: (See Diagram B-2, Page B-2A).

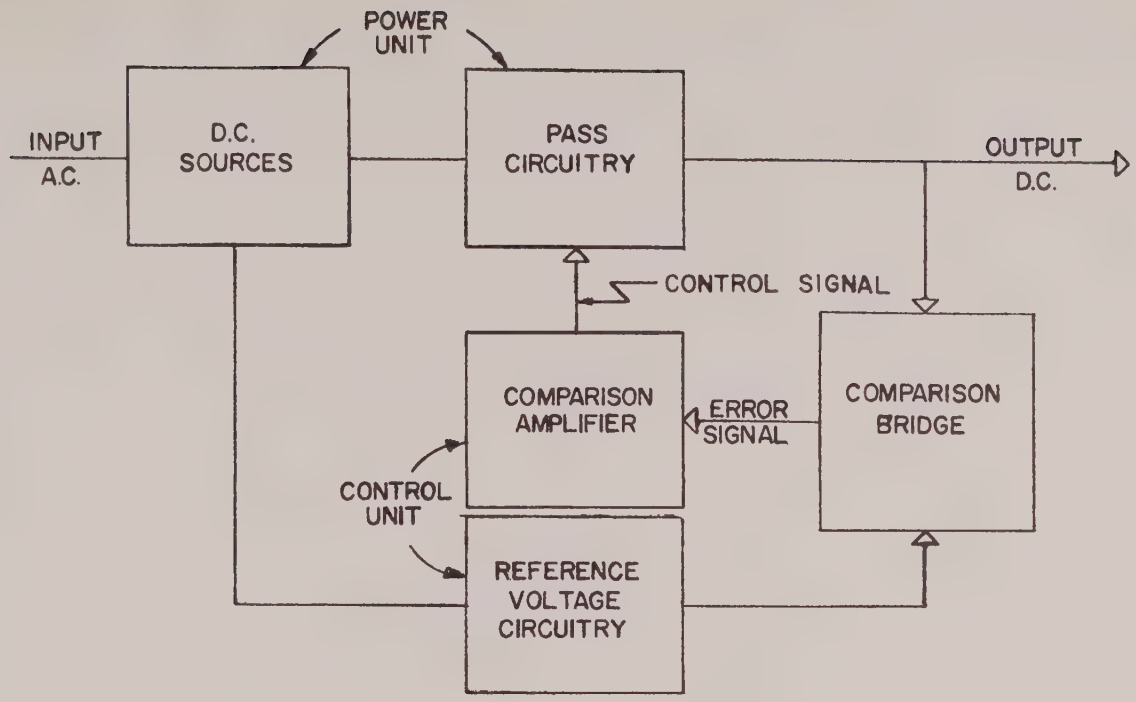
This bridge circuit implements the comparison between the OUTPUT VOLTAGE and the REFERENCE VOLTAGE. The signal produced by the comparison drives the COMPARISON AMPLIFIER.

Balance occurs in the Comparison Bridge when the following ratios are equal:

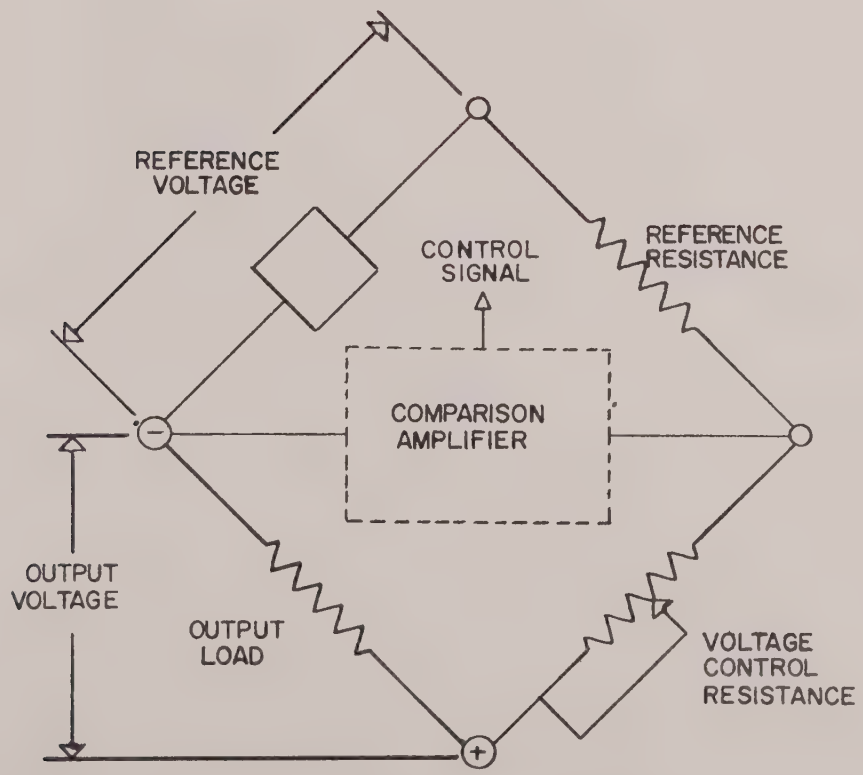
$$\frac{\text{Output Voltage}}{\text{Voltage Control Resistance}} = \frac{\text{Reference Voltage}}{\text{Reference Resistance}}$$

When, for example, the Comparison Bridge is unbalance by a decreasing output voltage drop across the load, it gives rise to a negative signal at the base of the COMPARISON FOLLOWER in the COMPARISON AMPLIFIER circuit. This signal is amplified in cascade and communicated to the pass elements as a negative base input aiding their forward conduction and consequently increasing the output voltage.

A bridge unbalance caused by an increasing output voltage produces, of course, a chain of oppositely biased circuit responses which reduce the voltage across the load.



(DIAGRAM B-1) *VOLTAGE REGULATED POWER SUPPLY*



(DIAGRAM B-2) *COMPARISON BRIDGE*

This power supply is shipped without any internal packing material; and may be put into operation immediately. It is designed for rack and for bench use. Carrying handles are provided on front panel.

....INTIAL "TURN - ON" PROCEDURE:

1. Adjust VOLTAGE CONTROL to approximate mid-range position.
2. With POWER ON-OFF switch set in "OFF" position, connect line cord to 115 v ac, 60 cps input power. If outlet is not polarized use 3 to 2 - prong adapter supplied with unit.
3. Set POWER ON-OFF switch to "ON" position.
4. Adjust VOLTAGE CONTROL to obtain desired output voltage.

....GENERAL OPERATION:

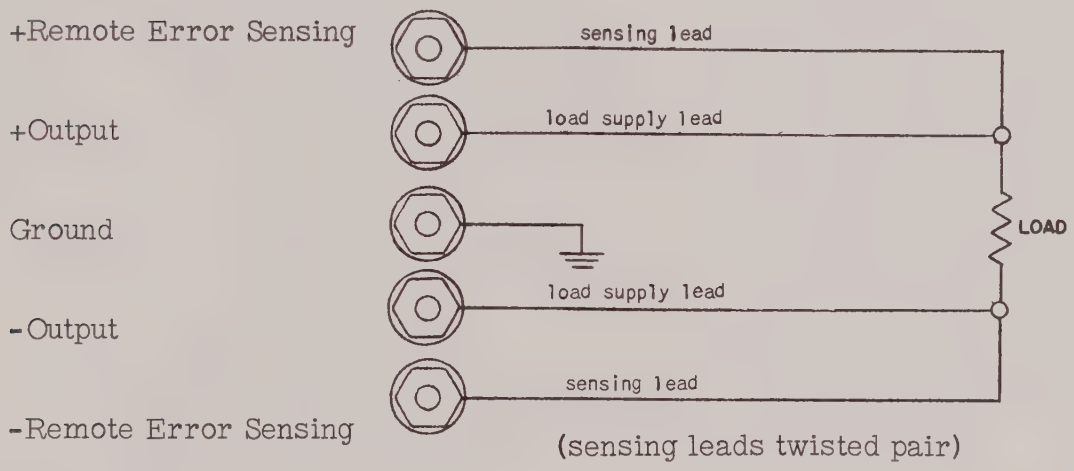
1. Once it has been determined that the unit is functioning satisfactorily, it is subsequently unnecessary to follow the INITIAL TURN-ON PROCEDURE.
2. The VOLTAGE CONTROL may be left fixed at any setting and the power turned "ON" and "OFF" without any harmful effects.

....MAINTENANCE AND REPAIR:

1. Under normal operating conditions, no mechanical maintenance of any kind should be required. Conservatively rated electrical components assure long trouble-free operating life.
2. Exceptional component accessibility, provided by resistor board construction and plug-in sub-assemblies, facilitates servicing, should it be required. It is emphatically recommended that trouble-shooting be handled by personnel highly familiar with transistor circuitry, - preferably with experience in closed-loop designs.
3. This unit should not be returned to the manufacturer without proper authorization and shipping instructions. In any correspondence with the factory regarding repair, the model, serial number, and symptoms of malfunction must be included.

REMOTE ERROR SENSING OPERATION

(Terminal Connections)



(sensing leads twisted pair)

(Procedure)

1. With AC input power disconnected, remove jumpers between plus and minus Output terminals and Remote Error Sensing terminals on the rear of the unit.

2. Using twisted pair wire, connect sensing leads from positive and negative Remote Error Sensing terminals to the load (observing polarities).

3. Using twisted pair wire, connect load supply leads from positive and negative Output terminals.

IMPORTANT NOTE: This unit should not be operated with Remote Error Sensing if the voltage drop across the load supply leads exceeds 0.5 volt (maximum) per lead at maximum rated output current.

Schematic Part No.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's. No.
B201	148-0006	Motor		Barber-Colman	KYAF764-1
		Capacitors:			
C101	117-0207	Mylar	1 µf 200 v 10%	Hopkins Eng.	1P2MK
C201	117-0274	Electrolytic, Can Type	5,900 µf 57.5 v +100,-10%	Sangamo	DCM
C202	117-0273	Electrolytic, Can Type	10,000 µf 57.5 v +100,-10%	Sangamo	DCM
C203	117-0169	Paper, Can Type	2 µf 660 v ac 6%	General Electric	49F2322
C301	117-0087	Ceramic	0.1 µf 500 v + 80,-20%	Sprague	41C92
C302	117-0291	Mylar	0.03 µf 200 v 20%	Hopkins Eng.	P032MK
C303	117-0122	Electrolytic, Pigtail Type	100 µf 50 v +100,-10%	Industrial Cond.	05RM1C0
C305	117-0147	Electrolytic, Pigtail Type	10 µf 150 v + 50,-10%	Industrial Cond.	10B912RM
C401	117-0114	Electrolytic, Pigtail Type	350 µf 50 v +100,-10%	Industrial Cond.	1B844
C402	117-0222	Electrolytic, Pigtail Type	100 µf 200 v + 50,-10%	Industrial Cond.	20B317RM
C403, 404	117-0221	Electrolytic, Pigtail Type	500 µf 50 v +100,-10%	Industrial Cond.	1B1163RM
C405, 406	117-0163	Ceramic	0.05 µf 500 v 20%	Sprague	36C142A1
		Rectifiers:			
CR301, 302	124-0028	Silicon, Pigtail Type		Automatic Mfg.	PT-5
CR401, 402, 405-408	124-0084	Silicon, Pigtail Type		Transitron	SL91
CR403, 404	124-0028	Silicon, Pigtail Type		Automatic Mfg.	PT-5
F101	141-0003	Fuse, Instantaneous	4 a 250 v	Bussmann	MTH-4
F102	141-0040	Fuse, Slow Blow	8 a 32 v	Bussmann	MDL-8
F401	141-0012	Fuse, Instantaneous	2 a 250 v	Bussmann	AGC-2

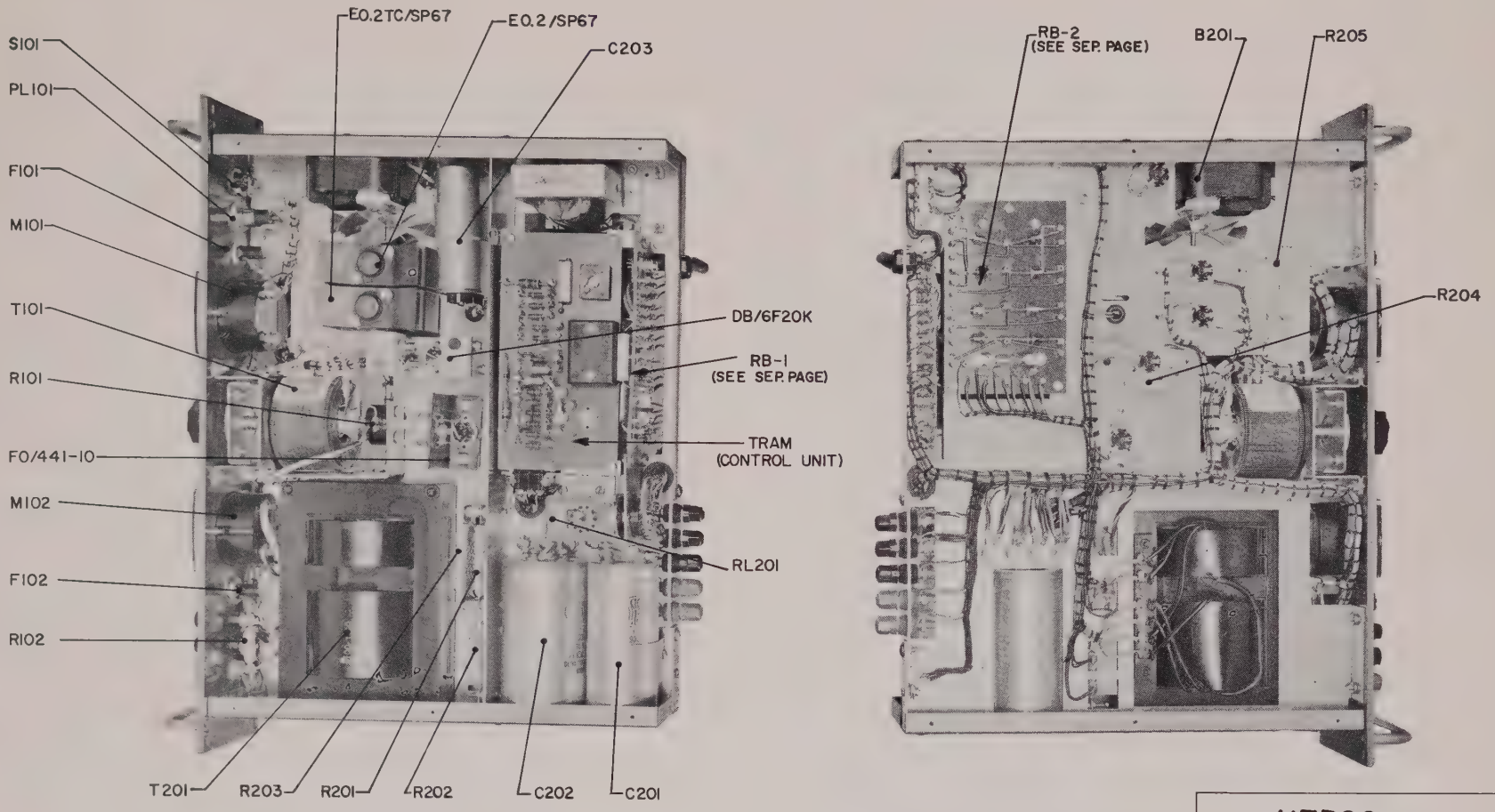
Schematic Part No.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's No.
M101	135-0138	Meter) only in "M" suffixed models	50 v dc 2-1/2"	Gen. Electric	8DW91V201AR2
M102	135-0171	)	5 a dc 2-1/2"	Gen. Electric	8DW91A227BT2
PL101	153-0024	Pilot Light, Neon		Gen. Electric	NE51
Q301	119-0022	Transistor, PNP		Tung-Sol	2N382
Q302	119-0034	Transistor, PNP		Delco	2N1172
		Resistors:			
R101	115-0878	Variable, Wire Wound	5 K ohms 1.6 w 5%	General Radio	971-M
R102, 204	115-0512	Fixed, Power, Axial	1 K ohms 5 w 5%	Ward Leonard	5X1000
R201, 203	115-1019	Fixed, Power, Ribbon	0.4 ohms 40 w 5%	Hardwick Hindle	2BR-35-0.4 ohm 5%-EW
R202	115-0981	Fixed, Power, Strip	1.5 K ohms 30 w 5%	Ward Leonard	30S1500
R205	115-0757	Fixed, Power, Strip	25 ohms 20 w 5%	Ward Leonard	20S25
R301	115-0559	Fixed, Molded	5.6 K ohms 1/2 w 5%	Allen Bradley	EB5625
R302	115-0960	Fixed, Molded	1 K ohms 1 w 5%	Allen Bradley	GB1025
R303	115-0564	Fixed, Power, Axial	400 ohms 3 w 5%	Ward Leonard	3X400
R304	115-0561	Fixed, Molded	270 ohms 1/2 w 10%	Allen Bradley	EB2711
R305, 310	115-0718	Fixed, Molded	47 ohms 1/2 w 10%	Allen Bradley	EB4701
R306	115-0890	Fixed, Molded	100 K ohms 1/2 w 10%	Allen Bradley	EB1041
R307	115-0883	Fixed, Molded	390 ohms 1/2 w 5%	Allen Bradley	EB3915
R308	115-0982	Fixed, Power, Axial	7.5 ohms 5 w 5%	Ward Leonard	5X7.5
R309	115-0595	Fixed, Molded	180 ohms 1 w 10%	Allen Bradley	GB1811
R311	115-0253	Fixed, Molded	82 K ohms 1/2 w 5%	Allen Bradley	EB8235
R312	115-0512	Fixed, Power, Axial	1 K ohms 5 w 5%	Ward Leonard	5X1000
R313	115-0502	Fixed, Molded	10 ohms 1/2 w 10%	Allen Bradley	EB1101

Schematic PartNo.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's. No.
RL201	140-0040	Relay	3 PDT	Kurman	26D3C
S101	127-0107	Switch, Toggle	SPST	Carling	AA252-71-2
T101	175-0402	Transformer, Variable		Ohmite	VT2LN
T201	100-1199	Transformer, Flux-O-Tran		Kepco Magnetics	100-1199
T401	100-1179	Transformer		Kepco Magnetics	100-1179
DB/6F20K	109-0021	RECTIFIER ASSEMBLY Includes the following:			
4 ea.	124-0086	Rectifier, Silicon, Stud Type		Int'l Rectifier	6F20K
E0.2/SP67	110-0127	PASS ASSEMBLY (STAT) Includes the following:			
1 ea.	115-0450	Resistor, Fixed, Power, Axial	0.2 Ω 3 w 5%	Ward Leonard	7/16-Q-0.2-Axiohm-5%
1 ea.	119-0035	Transistor, PNP		Motorola	SP67*
E0.2TC/SP67	110-0126	PASS ASSEMBLY (STAT) Includes the following:			
1 ea.	115-0450	Resistor, Fixed, Power, Axial	0.2 Ω 3 w 5%	Ward Leonard	7/16-Q-0.2-Axiohm-5%
1 ea.	127-0093	Switch, Thermostat	N. C.	Chatham Controls	DRSCORP. 73C
1 ea.	119-0035	Transistor, PNP		Motorola	SP67*
F0/441-10	110-0128	PASS ASSEMBLY (STAT) Includes the following:			
1 ea.	119-0016	Transistor, PNP		Delco	2N441

*=Field Replacement: 2N1163

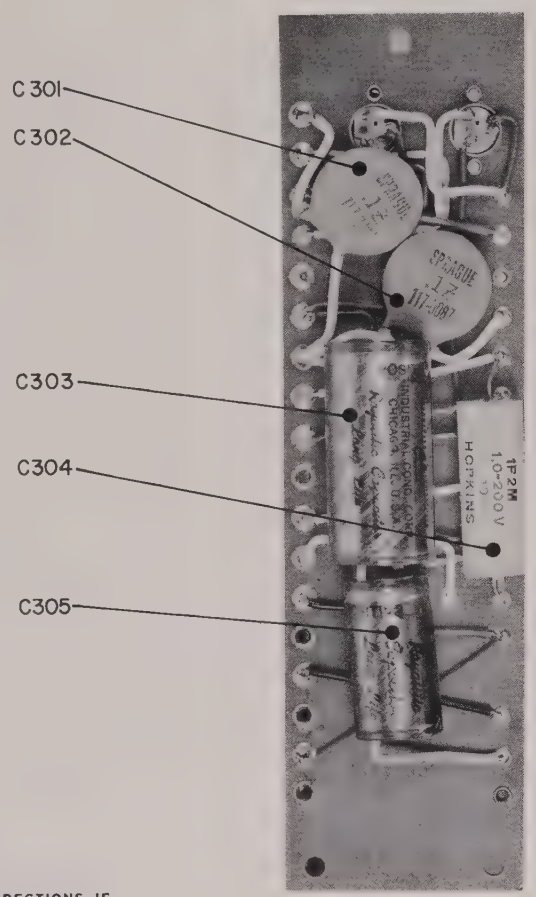
Schematic Part No.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's. No.
		Capacitors:			
C1	117-0107	Mylar	0.22 µf 200 v 20%	Good-All	620S22402W
C2	117-0087	Ceramic	0.1 µf 500 v + 80, -20%	Sprague	41C92
C3	117-0105	Electrolytic, Pigtail Type	25 µf 25 v +100, -10%	Industrial Cond.	1B1063
C4	117-0128	Mylar	0.4 µf 200 v 10%	Hopkins Eng.	P42MK
CR1,2	124-0084	Rectifier, Silicon, Pigtail Type		Transitron	SL-91
Q1,4,5	119-0024	Transistor, NPN		Gen. Transistor	GT1092
Q2	119-0022	Transistor, PNP		Tung-Sol	2N382
Q3	119-0007	Transistor, NPN		Gen. Transistor	2N35
Q6	119-0034	Transistor, PNP		Delco	2N1172
		Resistors:			
R1	115-0002	Fixed, Molded	100 Ω 1 w 10%	Allen-Bradley	GB1011
R2	115-0502	Fixed, Molded	10 Ω 1/2 w 10%	Allen-Bradley	EB1001
R3	115-0467	Fixed, Molded	4.7K Ω 1/2 w 10%	Allen-Bradley	EB4721
R4	115-0484	Fixed, Molded	240 Ω 1/2 w 5%	Allen-Bradley	EB2415
R5	115-0565	Fixed, Molded	620 Ω 1/2 w 5%	Allen-Bradley	EB6215
R6	115-0941	Fixed, Molded	82 Ω 1/2 w 10%	Allen-Bradley	EB8201
R7	115-0560	Fixed, Molded	2.7K Ω 1/2 w 10%	Allen-Bradley	EB2721
R8	115-0808	Fixed, Molded	3.9K Ω 1/2 w 5%	Allen-Bradley	EB3925
R9,10	115-0459	Fixed, Power, Axial	500 Ω 3 w 5%	Ward Leonard	3X500
R11,15	115-0888	Fixed, Molded	560 Ω 1/2 w 5%	Allen-Bradley	EB5615

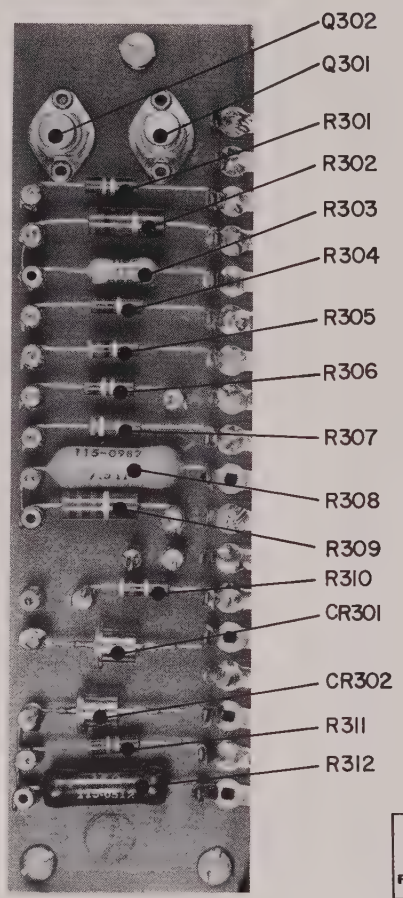
Schematic Part No.	Kepco Part No.	Description	Specifications	Mfr.	Mfr's. No.
		Resistors:			
R12	115-0920	Fixed, Molded	13 K Ω 1/2 w 5%	Allen-Bradley	EB1335
R13	115-0473	Fixed, Molded	1.8 K Ω 1/2 w 10%	Allen-Bradley	EB1821
R14	115-0566	Fixed, Molded	750 Ω 1/2 w 5%	Allen-Bradley	EB7515
R16	115-0466	Fixed, Molded	2.2 K Ω 1/2 w 10%	Allen-Bradley	EB2221
R17	115-0005	Fixed, Molded	47 Ω 1 w 10%	Allen-Bradley	GB4701
R18	115-0052	Fixed, Molded	10 Ω 1 w 10%	Allen-Bradley	GB1001
R19	115-0739	Variable, Multiturn	1 K Ω 1/4 w 10%	Bourns	271-1-102
R20	115-0255	Fixed, Molded	56 K Ω 1/2 w 10%	Allen-Bradley	EB5631
RD1	121-0013	Reference Diode		Hoffman	RS-6



CORRECTIONS, IF ANY, APPEAR ON SHEET ATTACHED TO REAR COVER

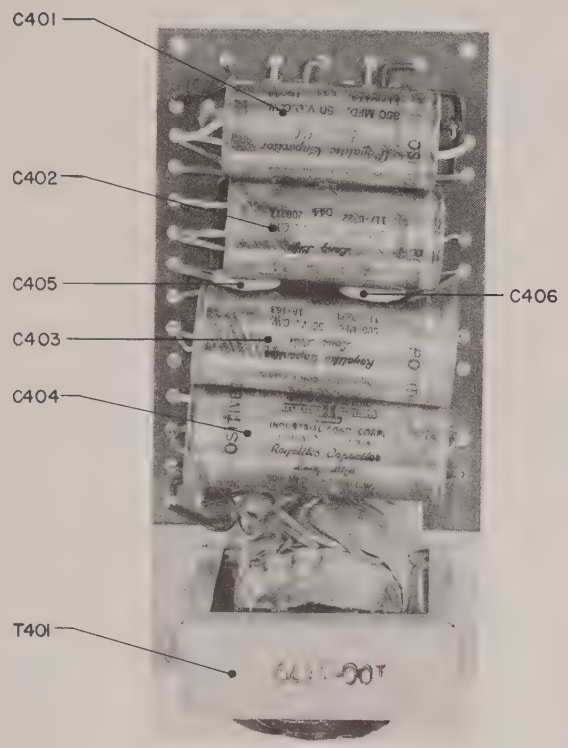
KEPCO INC.	
FLUSHING NEW YORK	
ITEM POWER UNIT	DES. 1-5-61
	APPD TPK
MODEL SM-36-5	DFTM M. CEA
DWG. No BM00925	CHKD TPK

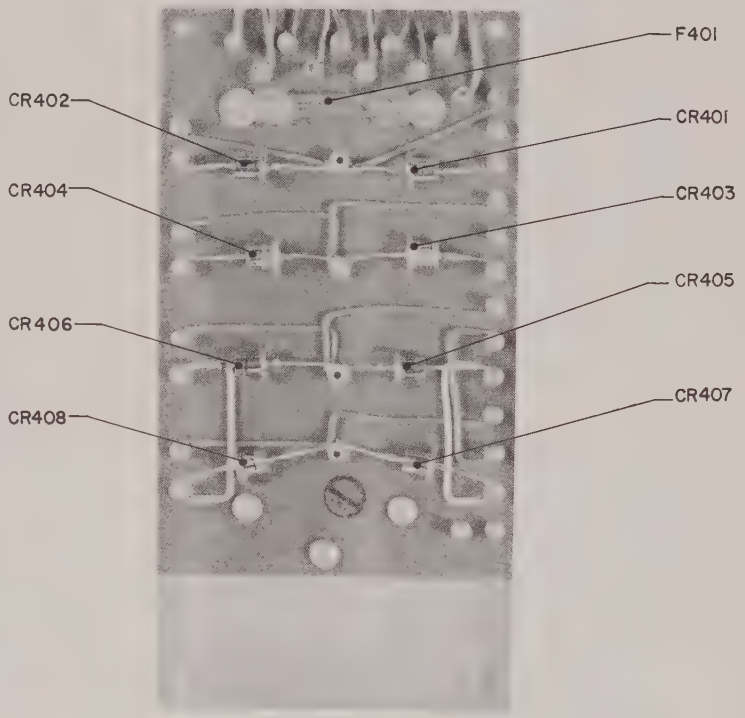




CORRECTIONS, IF ANY, APPEAR ON SHEET ATTACHED TO REAR COVER

KEPCO INC.	
FLUSHING NEW YORK	
ITEM RB-1	DES. 12-22-60
	APPD J. Byerss
MODEL SM-36-5	DFTN M. CEA
DWG. No. BM00907	CHKD T. Dal





CORRECTIONS, IF ANY, APPEAR ON SHEET ATTACHED TO REAR COVER

KEPCO INC.	
FLUSHING NEW YORK	
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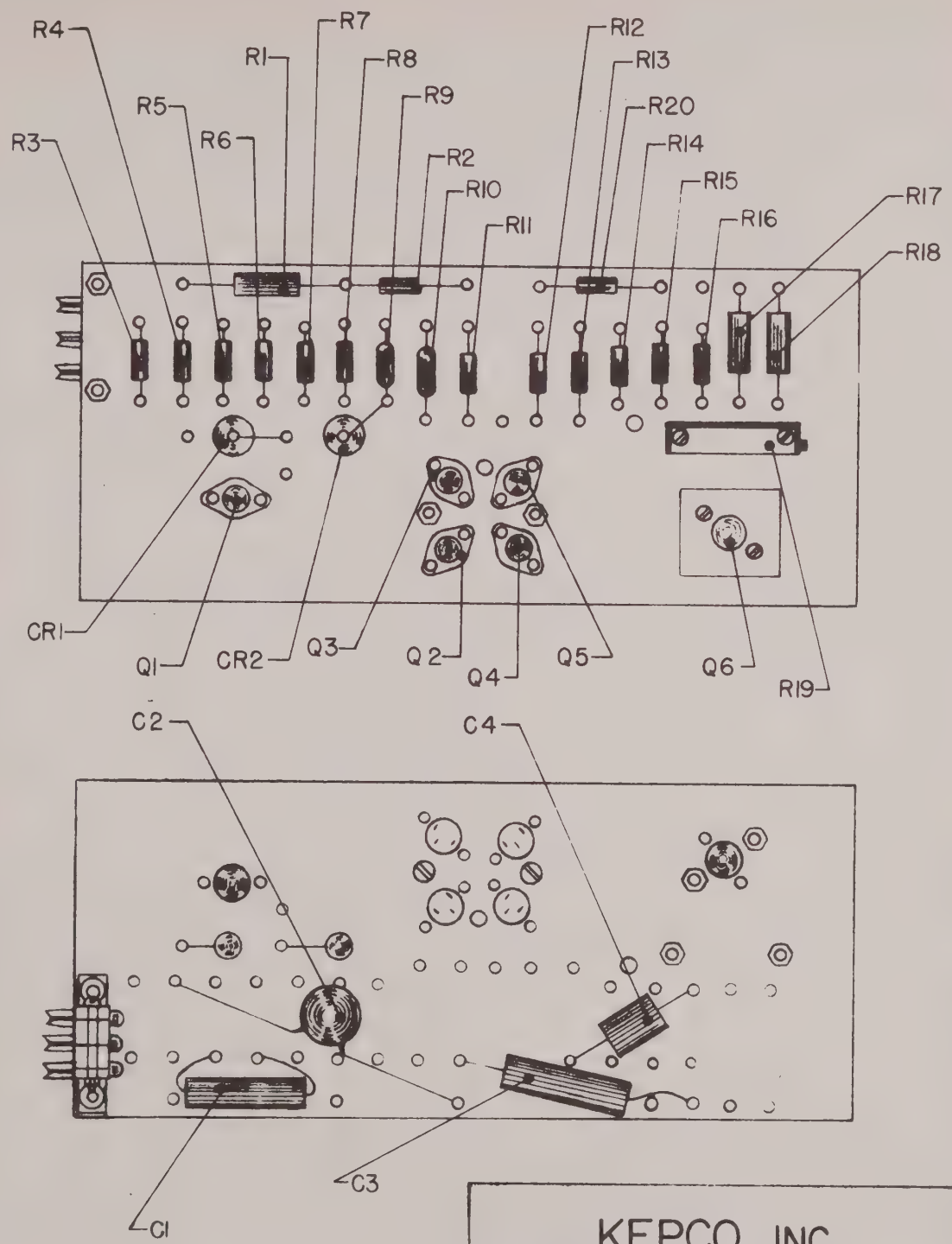
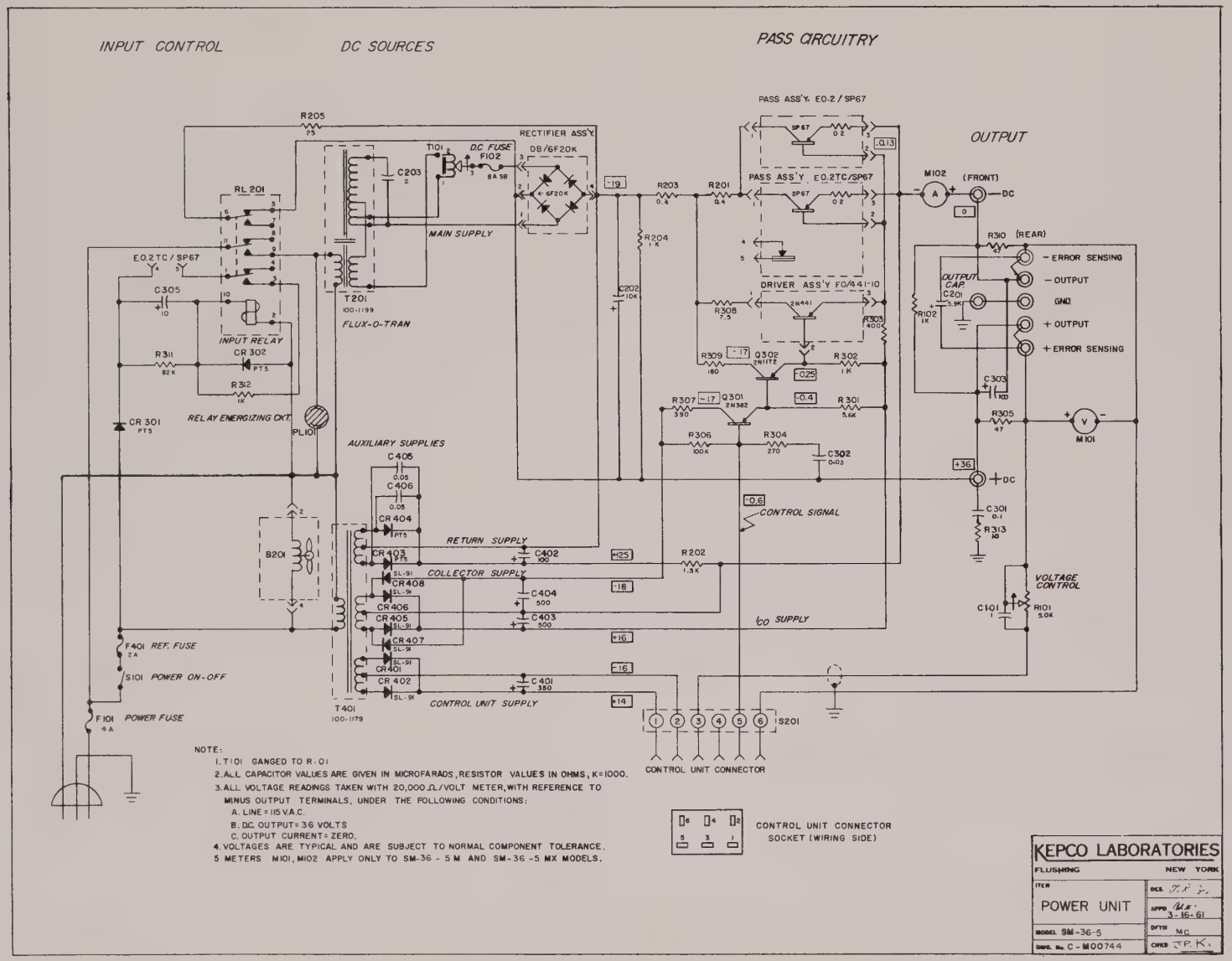
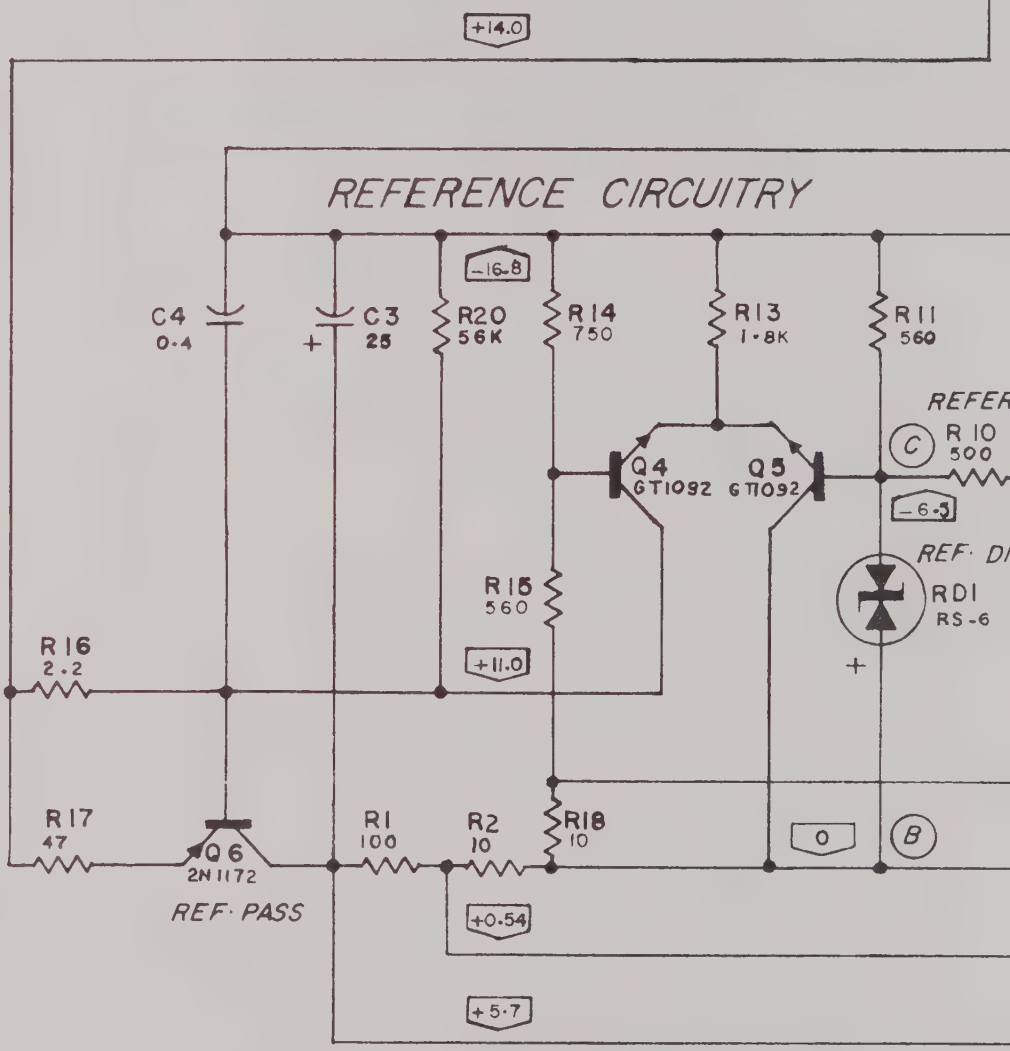
MODEL SM—— SERIES	DFTM M.CEA
DWG. No. BM00923	CHKD



KEPCO INC.	
FLUSHING NEW YORK	
ITEM: CONTROL UNIT	DES 3-1-61
	APPD J.P.K.
MODEL TRAM-32	DFTM R.C.
DWG No AM01073	CHKD

ORDER REPLACEMENT PARTS BY KEPCO PART NUMBER
PROVIDED IN PARTS LIST SECTION



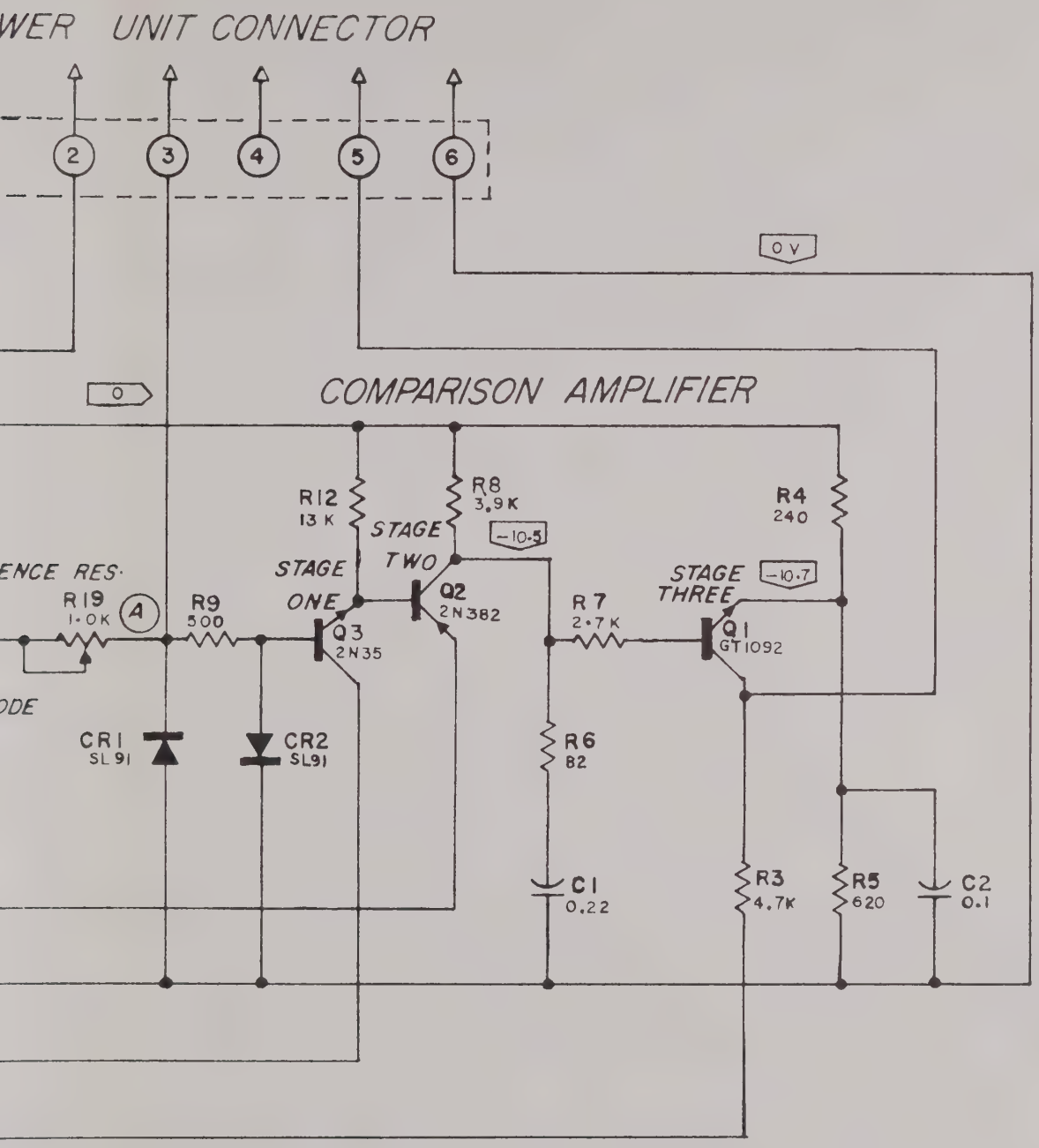


NOTES:

1- ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SCHEMATIC

2- ALL CAPACITOR VALUES ARE GIVEN IN MICROFARADS, RESISTOR VALUES IN OHMS, UNLESS OTHERWISE NOTED. (K= 1,000 OHMS)

3- ORDER REPLACEMENT PARTS BY KEPCO PART PROVIDED IN PARTS LIST SECTION.



NUMBER

KEPCO INC.
FLUSHING, N.Y.

TITLE			
CONTROL UNIT			
DRAWN	CHECKED	APPROVED	DATE
C.A.	JPK	[illegible]	12-2-60
MODEL NO.		PART NO.	SCALE
TRAM 32			
DWG NO. BM00790			

Kepco inc.

MP MASTER
MA33932

KEPCO, INC. • 131-38 SANFORD AVENUE • FLUSHING 55, N. Y. • IN 1-7(00